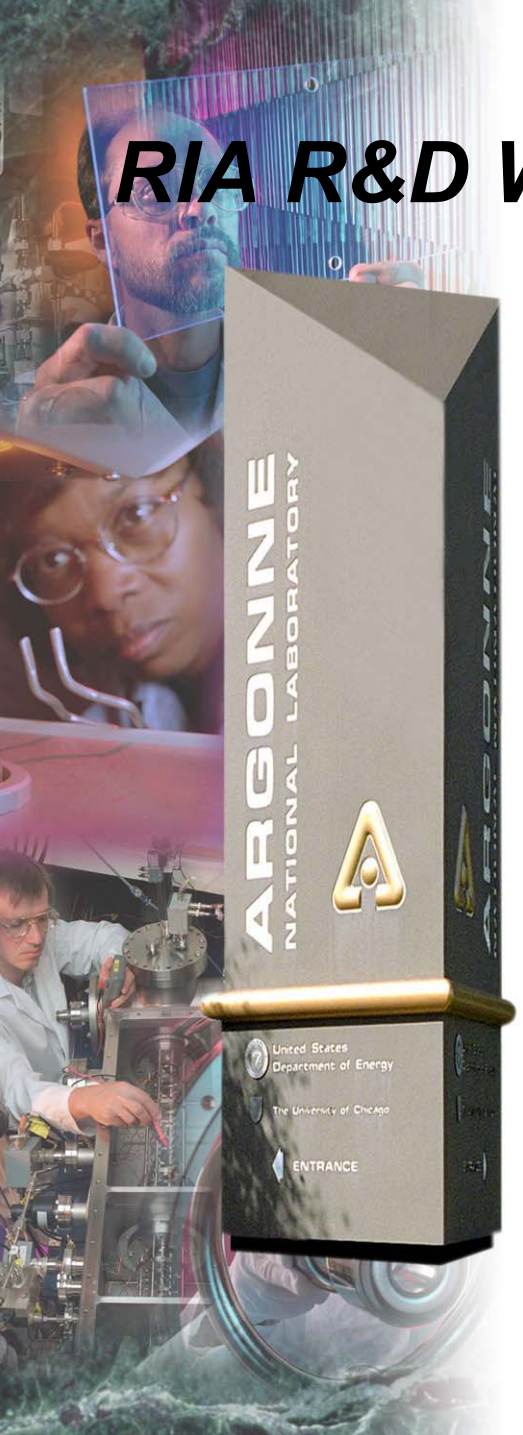

RIA R&D Workshop

RIA Fragment Separator Studies

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Physics Division

(paper 3.3.2)

Argonne National Laboratory

Office of Science
U.S. Department of Energy

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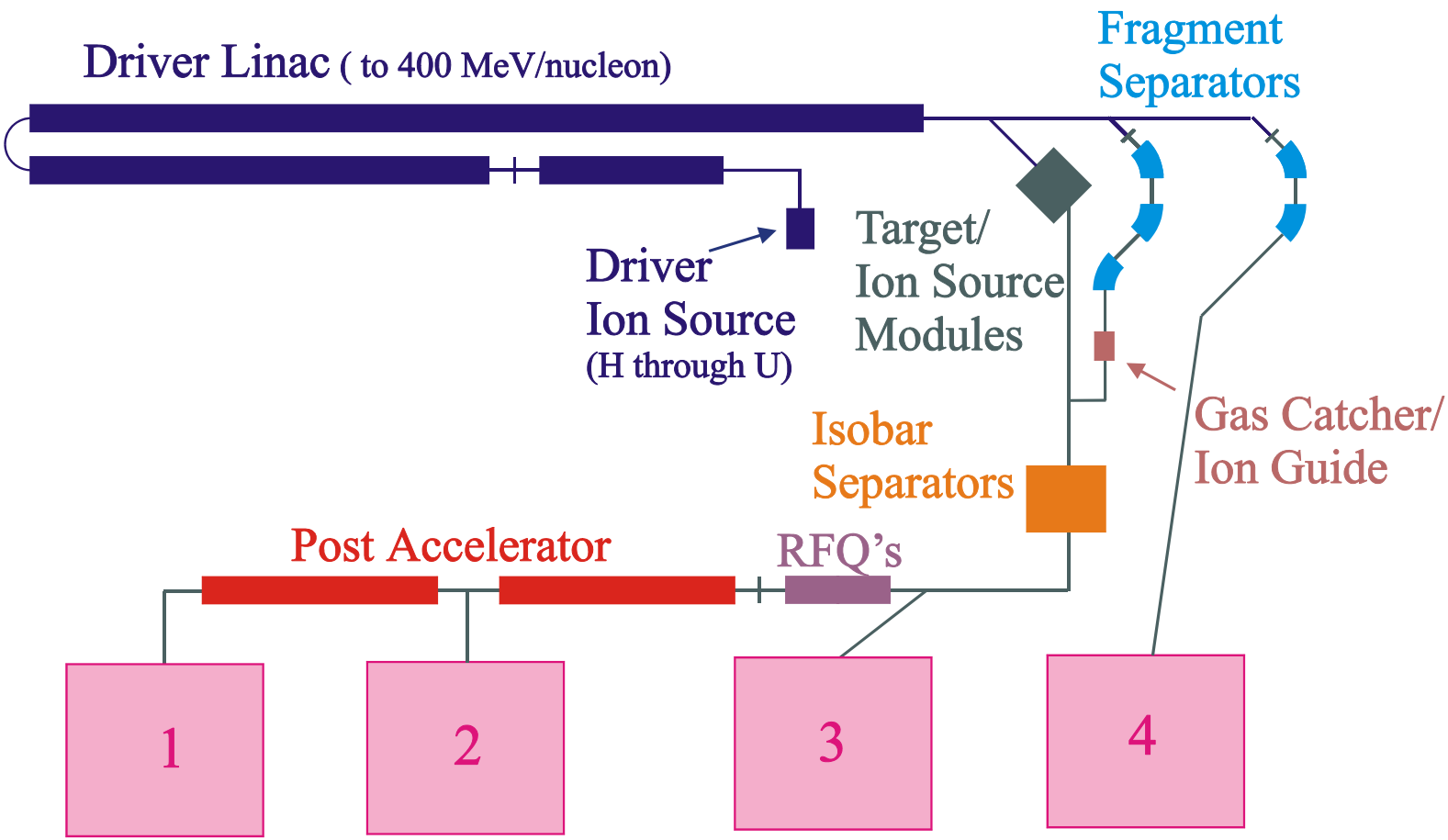
Office of Science Laboratory
Operated by The University of Chicago

Simplified Schematic Layout of the Rare Isotope Accelerator (RIA) Facility



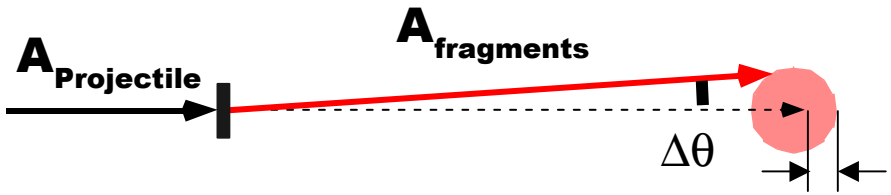
Experimental Areas:
1: < 12 MeV/u 2: < 1.5 MeV/u 3: Nonaccelerated 4: In-flight fragments

Purpose of fragment separators

1. *Central component linking production and experimental areas*
2. *separate reaction products from primary beam*
3. *handle and confine primary beam and radioactive contaminants*
4. *collect largest possible amount of selected isotopes and send:*
   - **in an identifiable form to high energy branch**
   - **achromatized, at low energy to gas catcher branch**

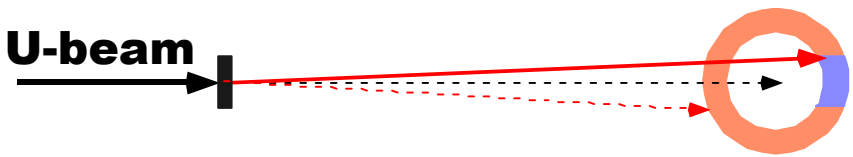
Production reactions -> separator requirements

1) Projectile Fragmentation



small Δθ ,
small Δp/p

2) In-Flight Fission of ^{238}U beam



400MeV/u
Δθ~ ±50mrad
Δp/p ~±6%

For neutron-rich RI beams

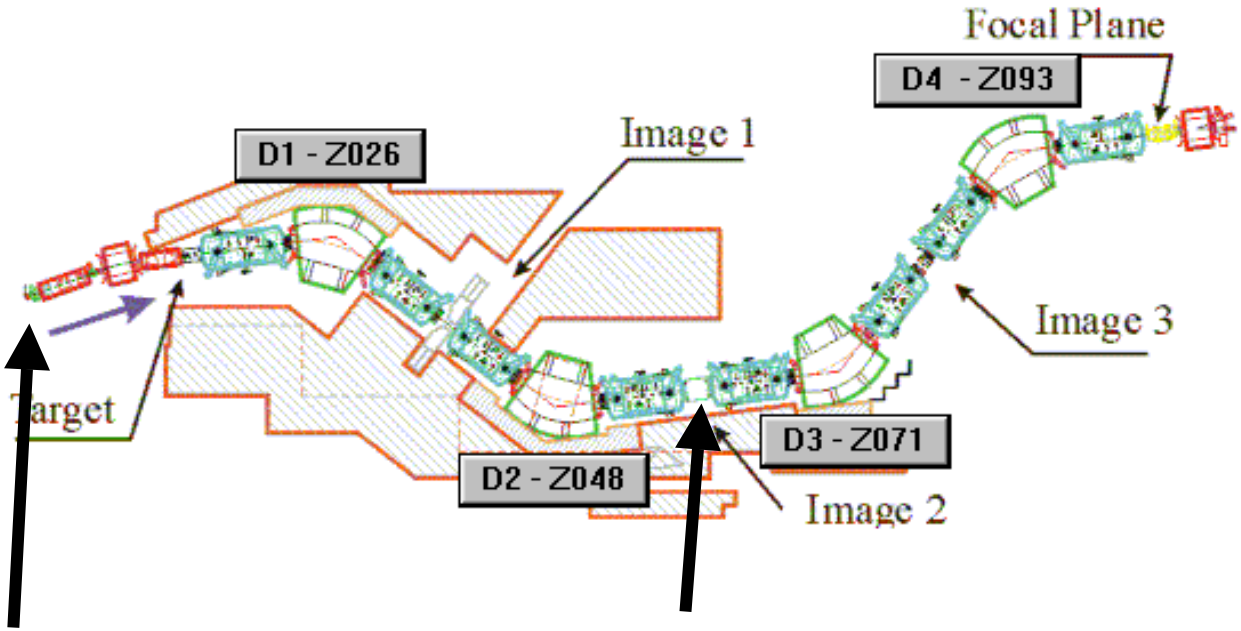
σ(fission) > σ(fragmentation)

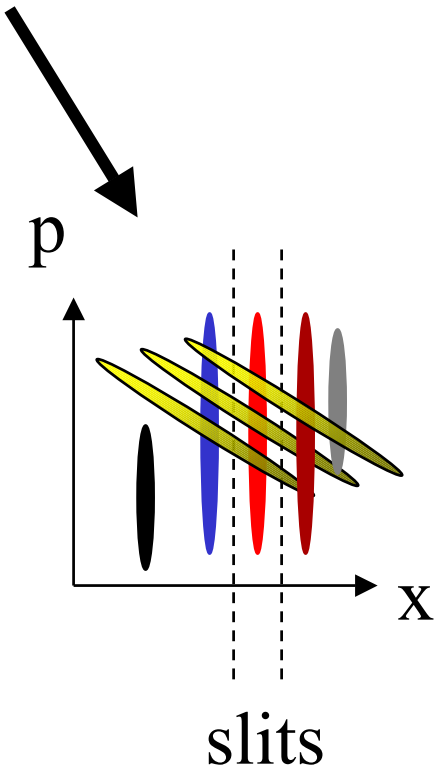
Large spreads → Large acceptance separator

Separator requirements

- optimized for high target thickness
- optimized for high acceptance for fission fragments
- radiation resistant, radiation control
- two separators required
  - High-energy branch → high resolution, +- 50 mrad, +- 3% dp
  - Low-energy branch → high resolution, +- 50 mrad, +- 9% dp, achromatization to 0.1% dp

Study of selection process: secondary reactions in intermediate wedge

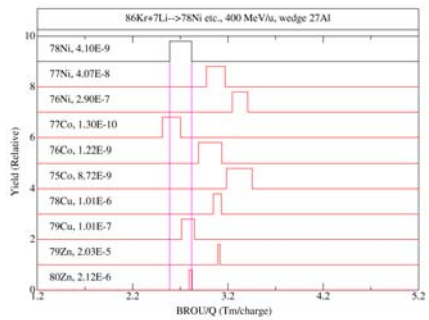




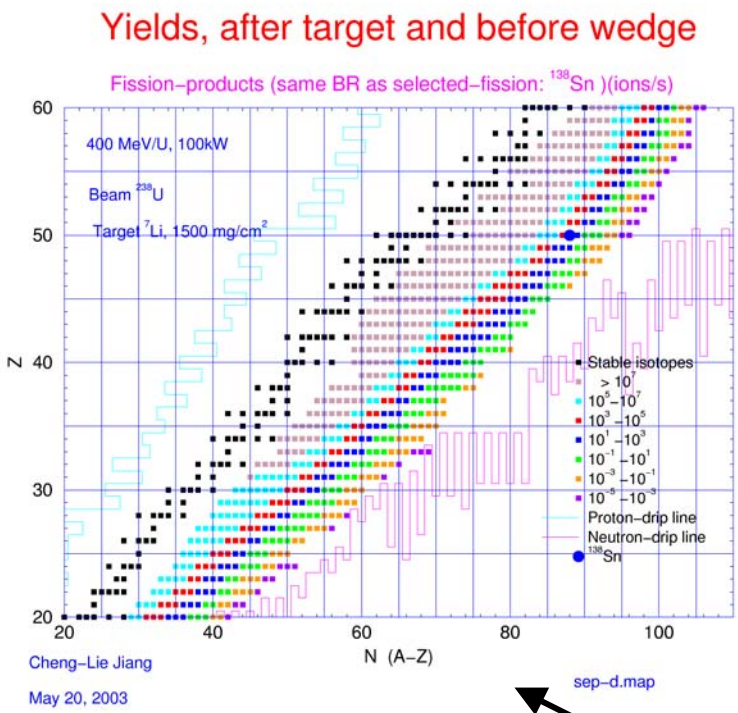
Primary production

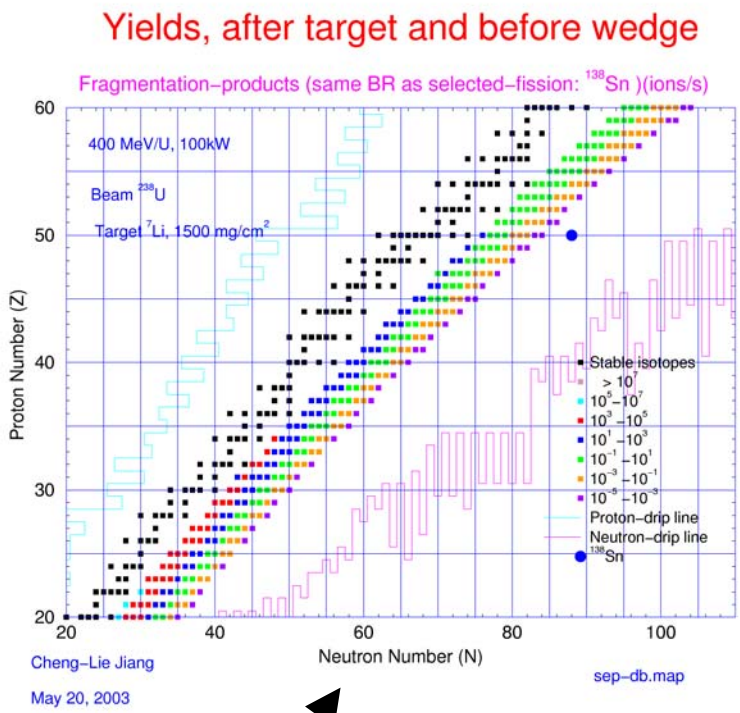
Production by primary fragments in thick wedge

We developed a new code to handle this contamination for fragmentation and fission.



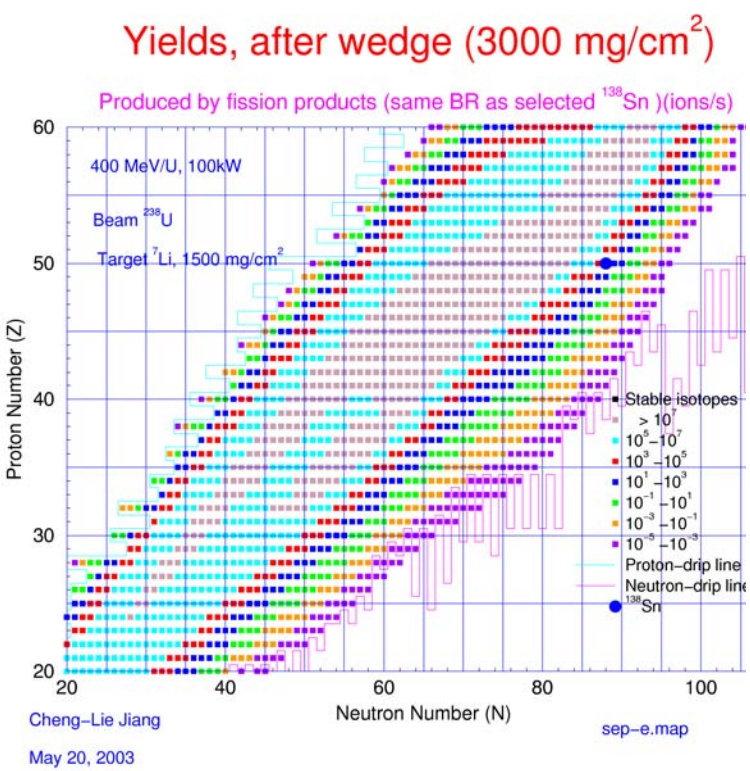
Production and separation of fission fragments (1)

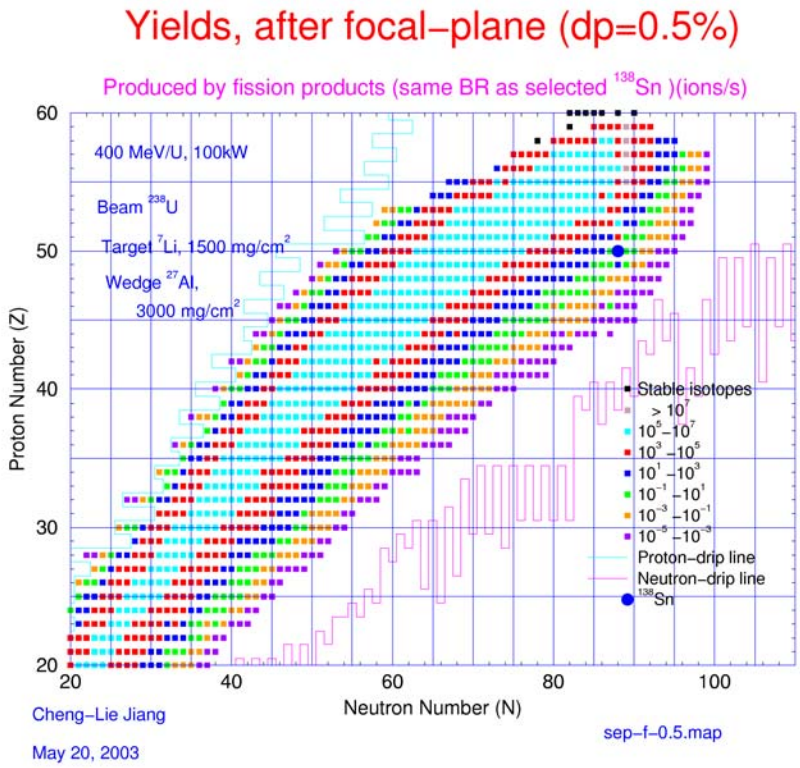




Production with fission and fragmentation within Bρ acceptance

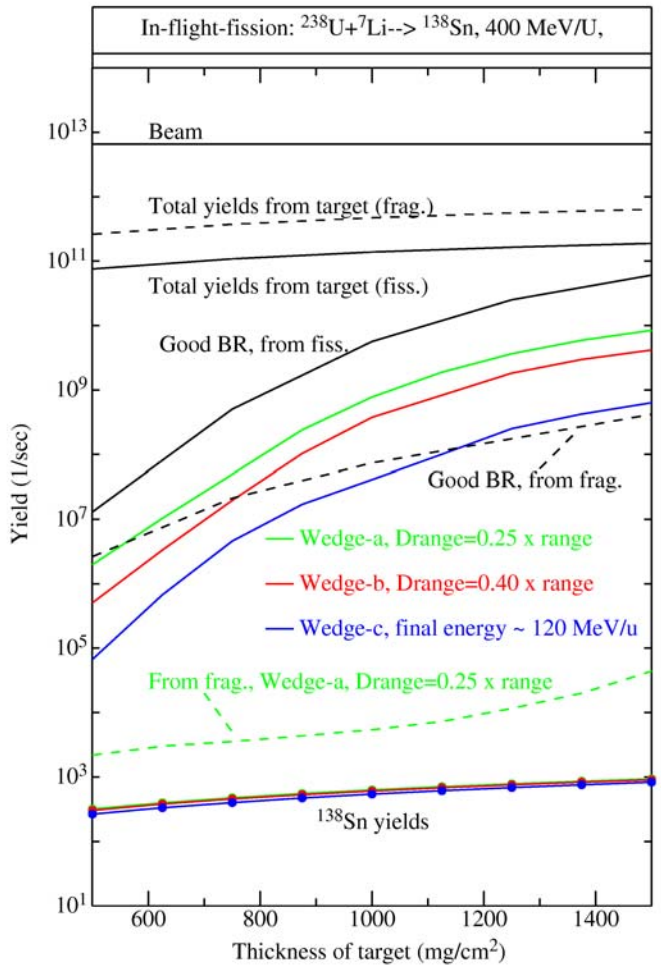
Production and separation of fission fragments (2)

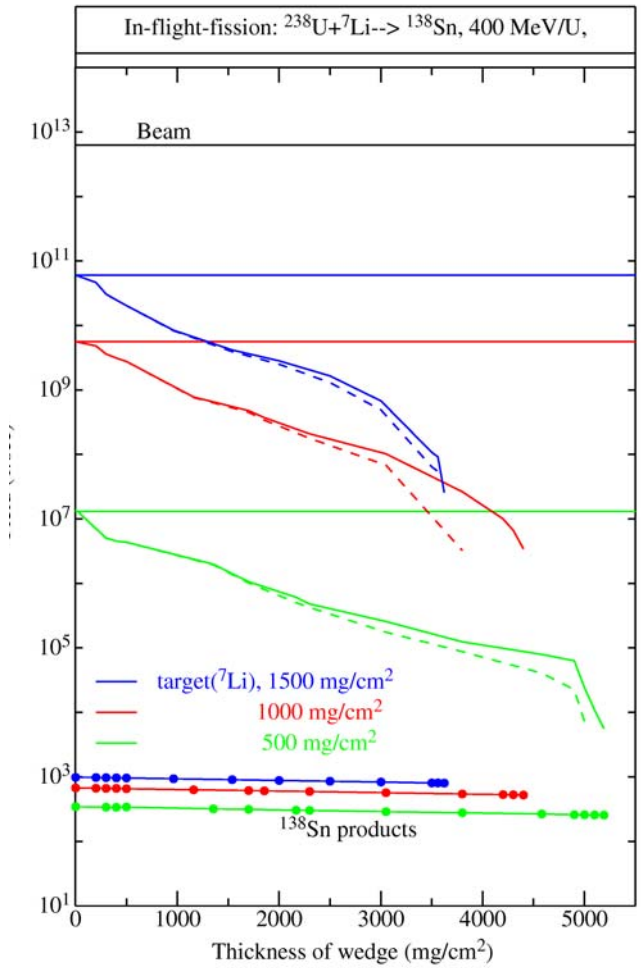




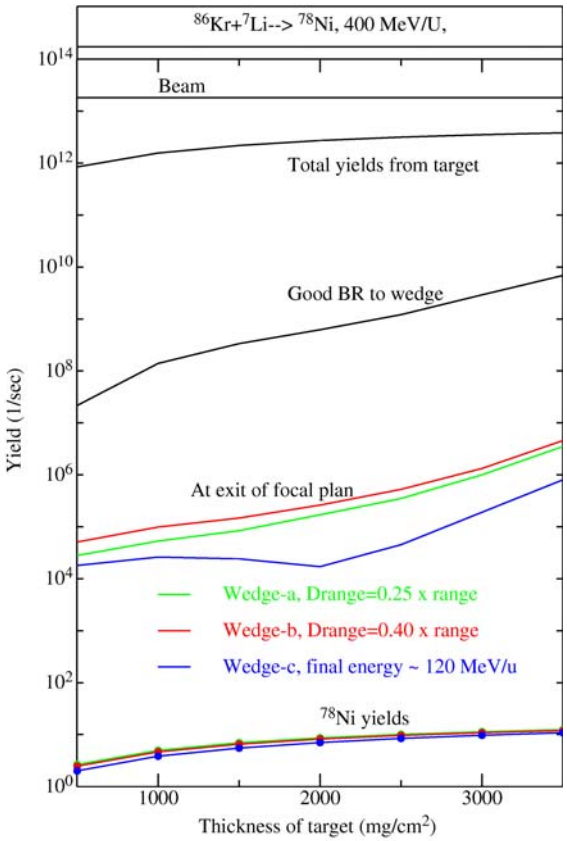
Activity after wedge and focal plane slits

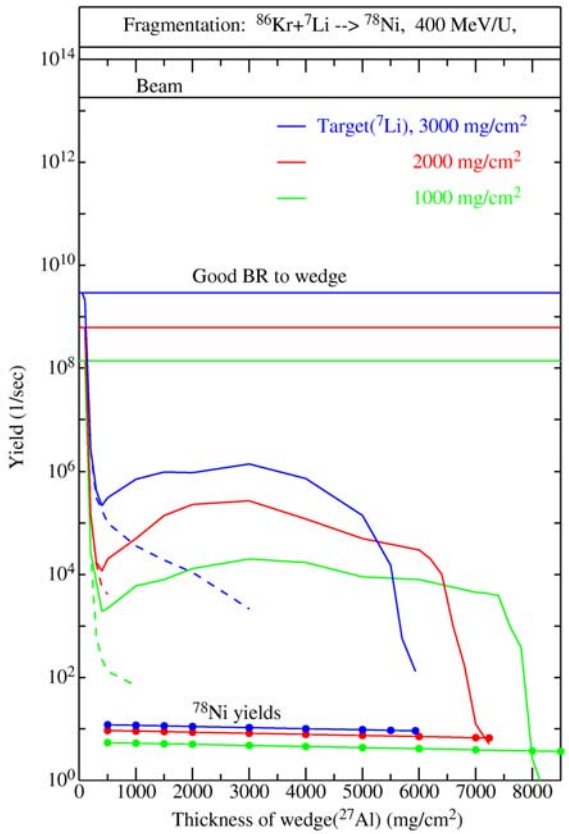
Contamination study for in-flight fission

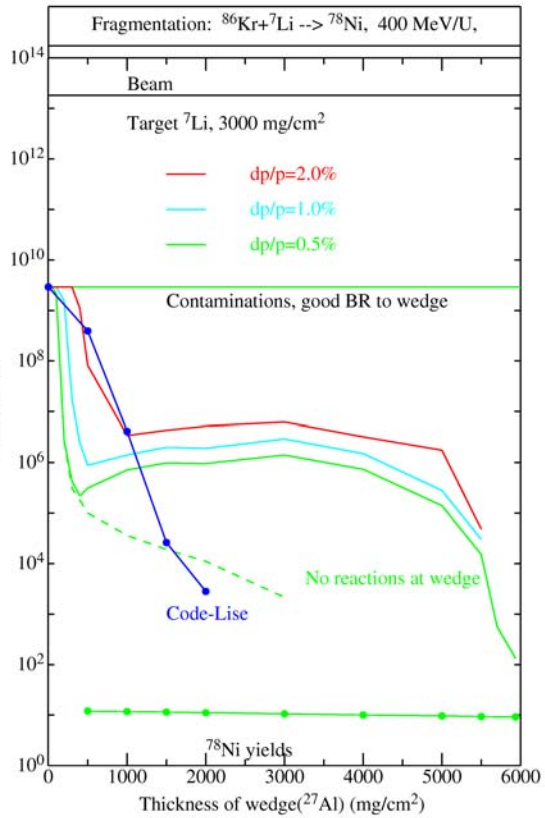




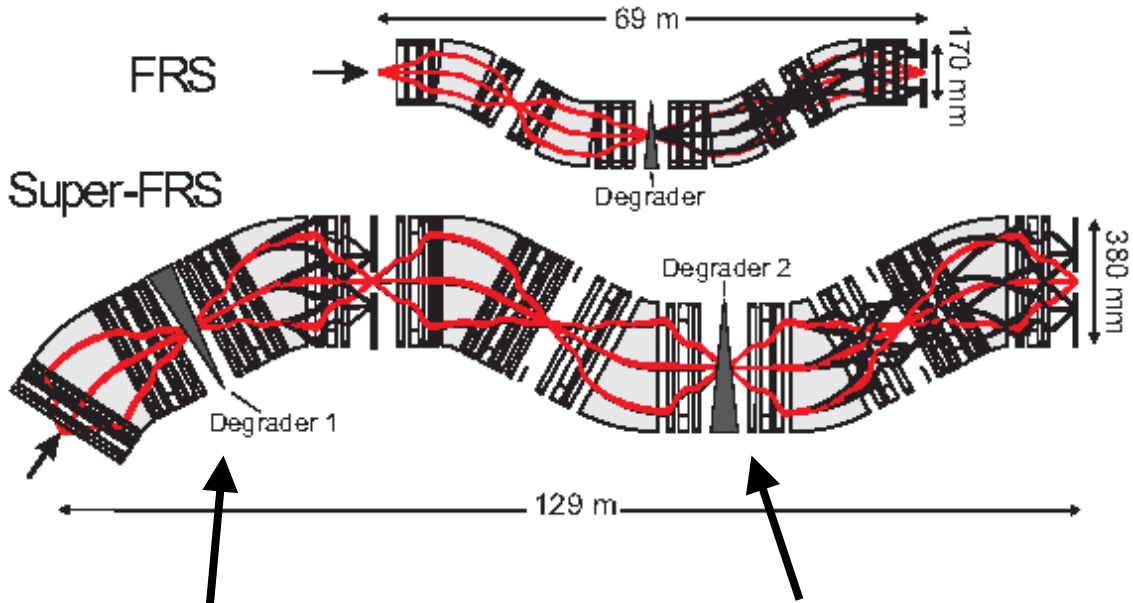
Study of contamination in fragmentation







Possible evolution: FRS and preseparator optical layouts



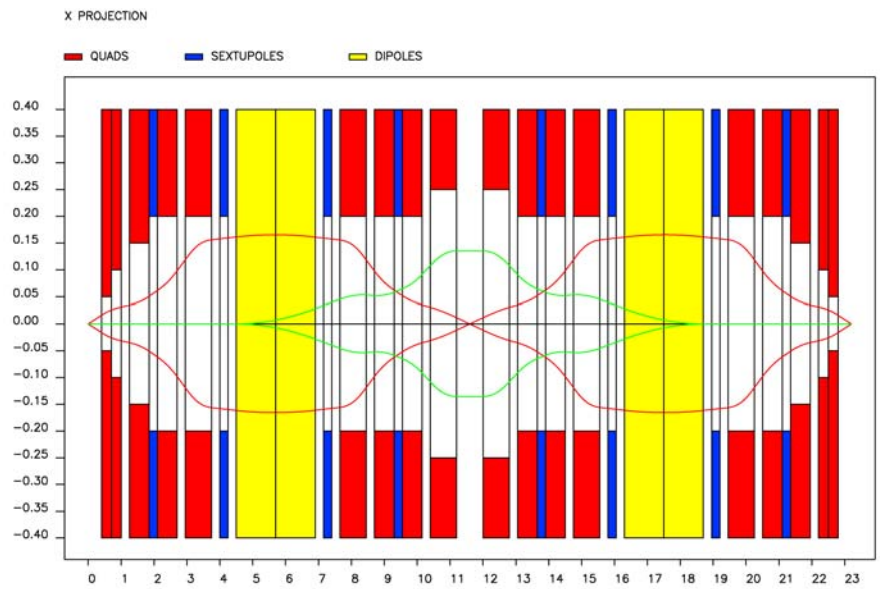
Pre-separator:
Cleans up bulk
of production

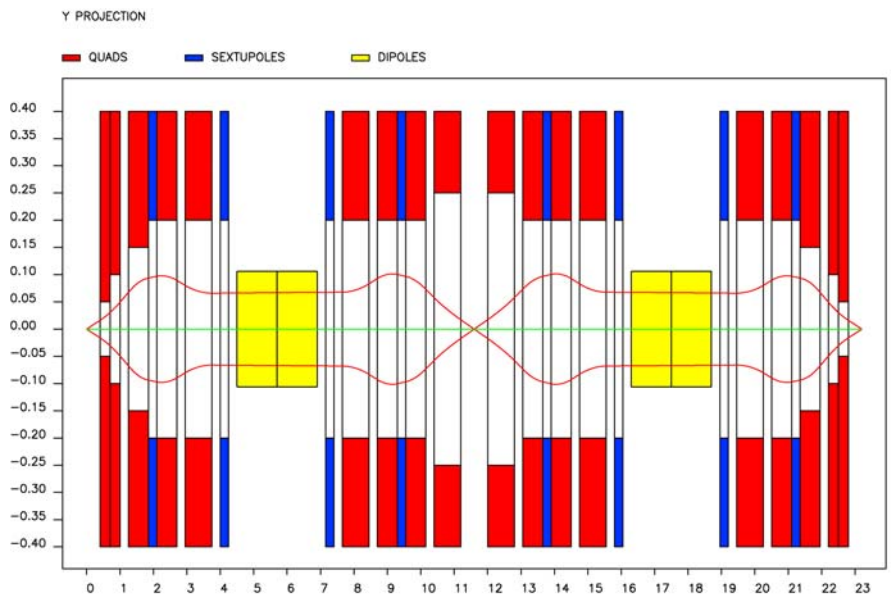
High-resolution separator:
Does final selection with
Reduced number of particles
hitting intermediate wedge

Removes dominating background for weakest channels

For more detailed ion optical studies: improvements to COSY code

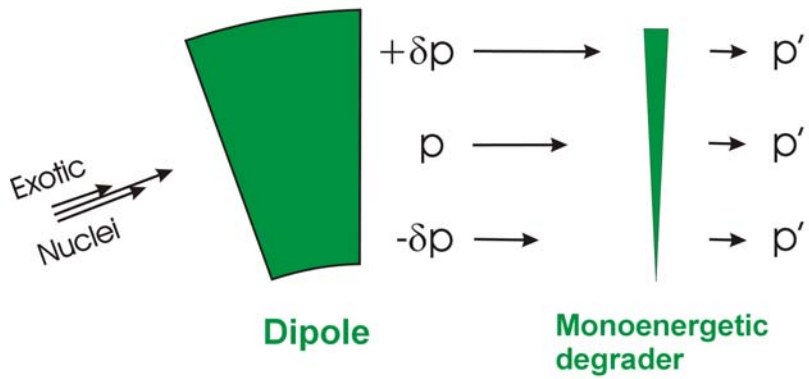
more detailed design of fragment separator with dp +- 9%, +- 50 mrad → determine gap sizes, position of beam dumps, higher order optics



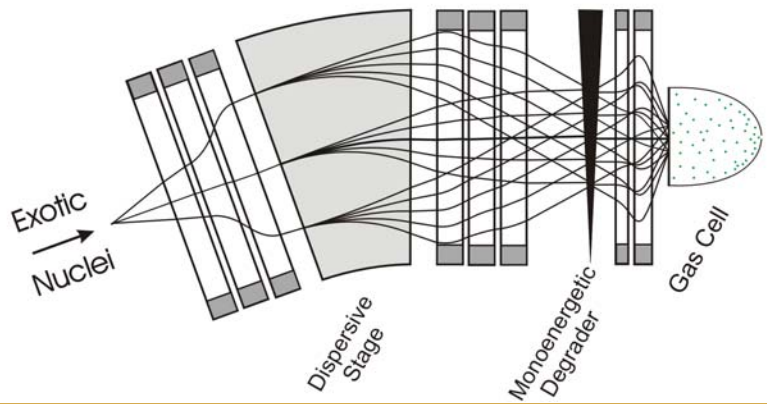


Energy and range focusing

Principle



Ion-optical design

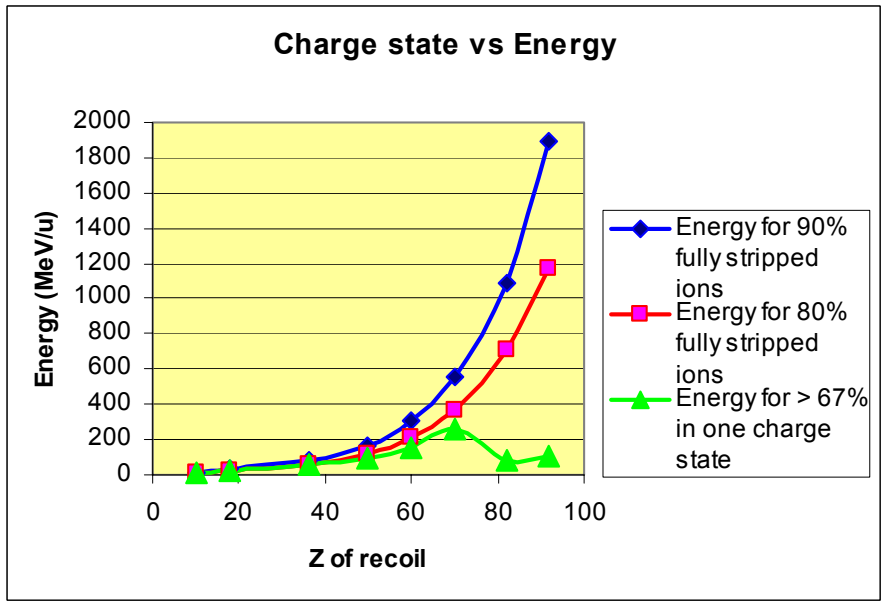


Separator design must take into account driver linac energy

- for 400 MeV/u (lower for recoils), high mass recoils will not be fully stripped

•must then choose recoil energy providing high concentration in one specific charge state

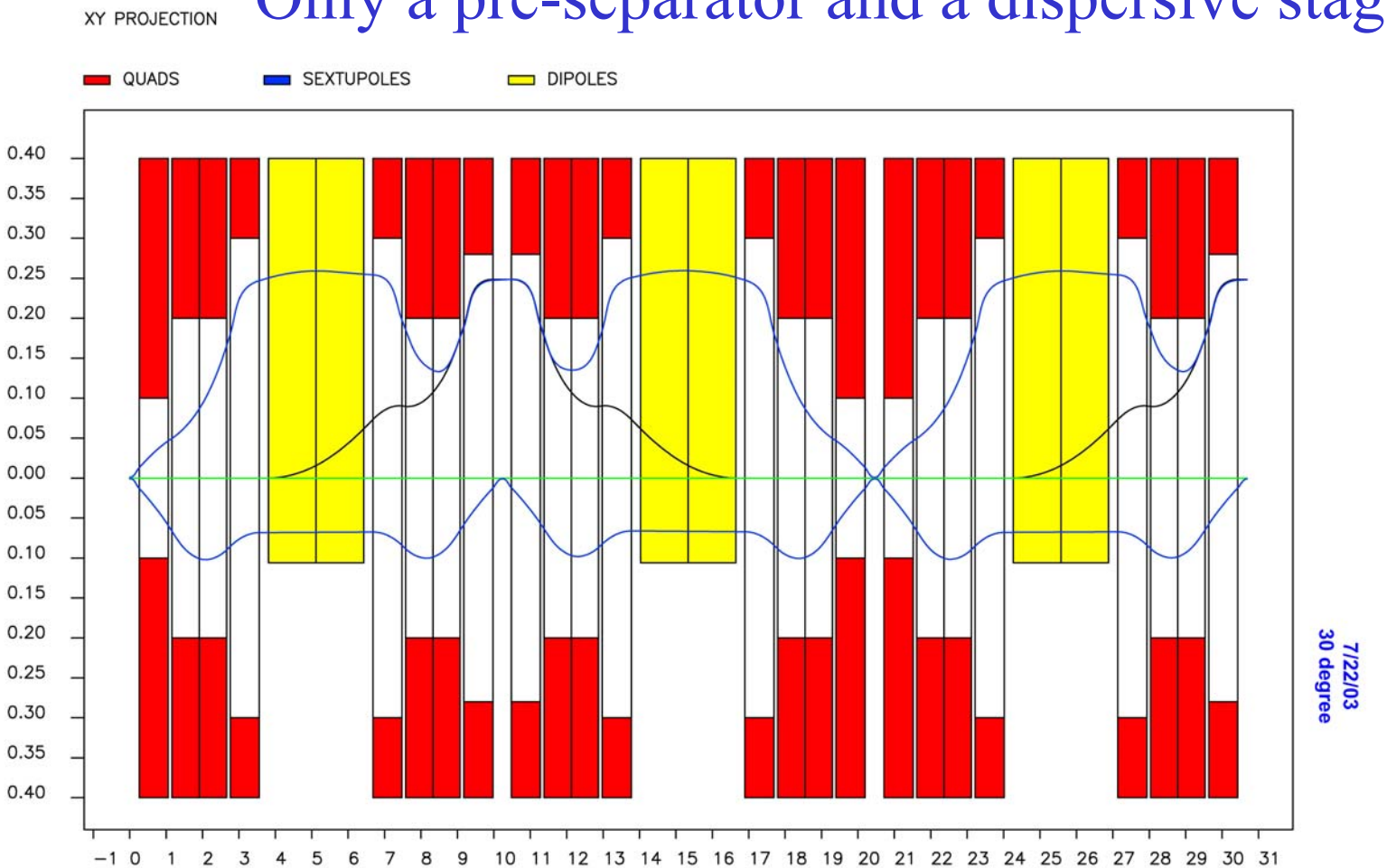
•charge-state distribution will lower yield at each wedge/absorber



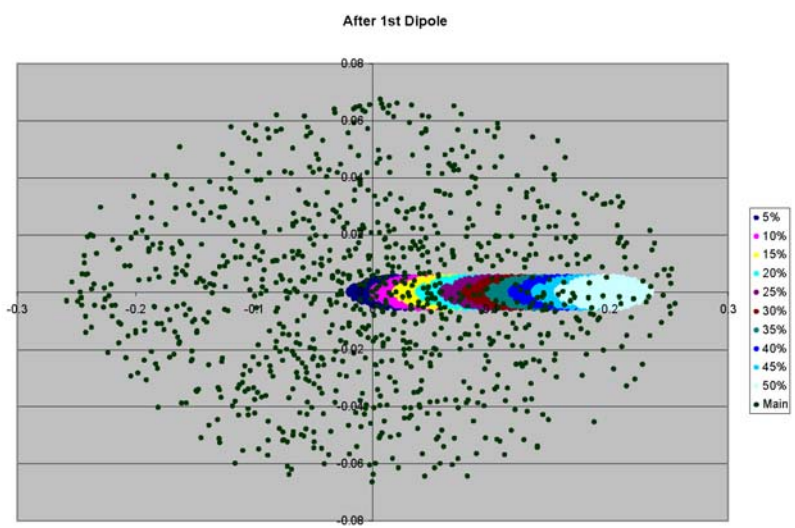
Number of wedges must be minimized for high-Z elements at RIA energy.

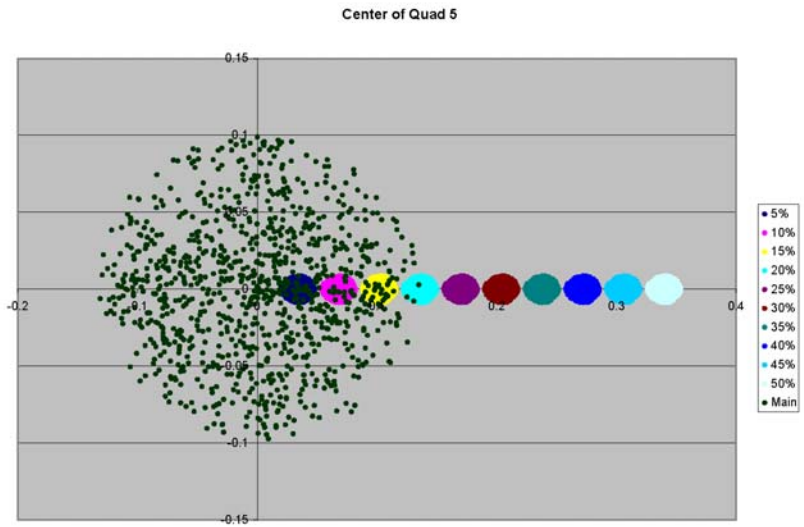
Current separator layout under study (low energy branch)

Only a pre-separator and a dispersive stage!

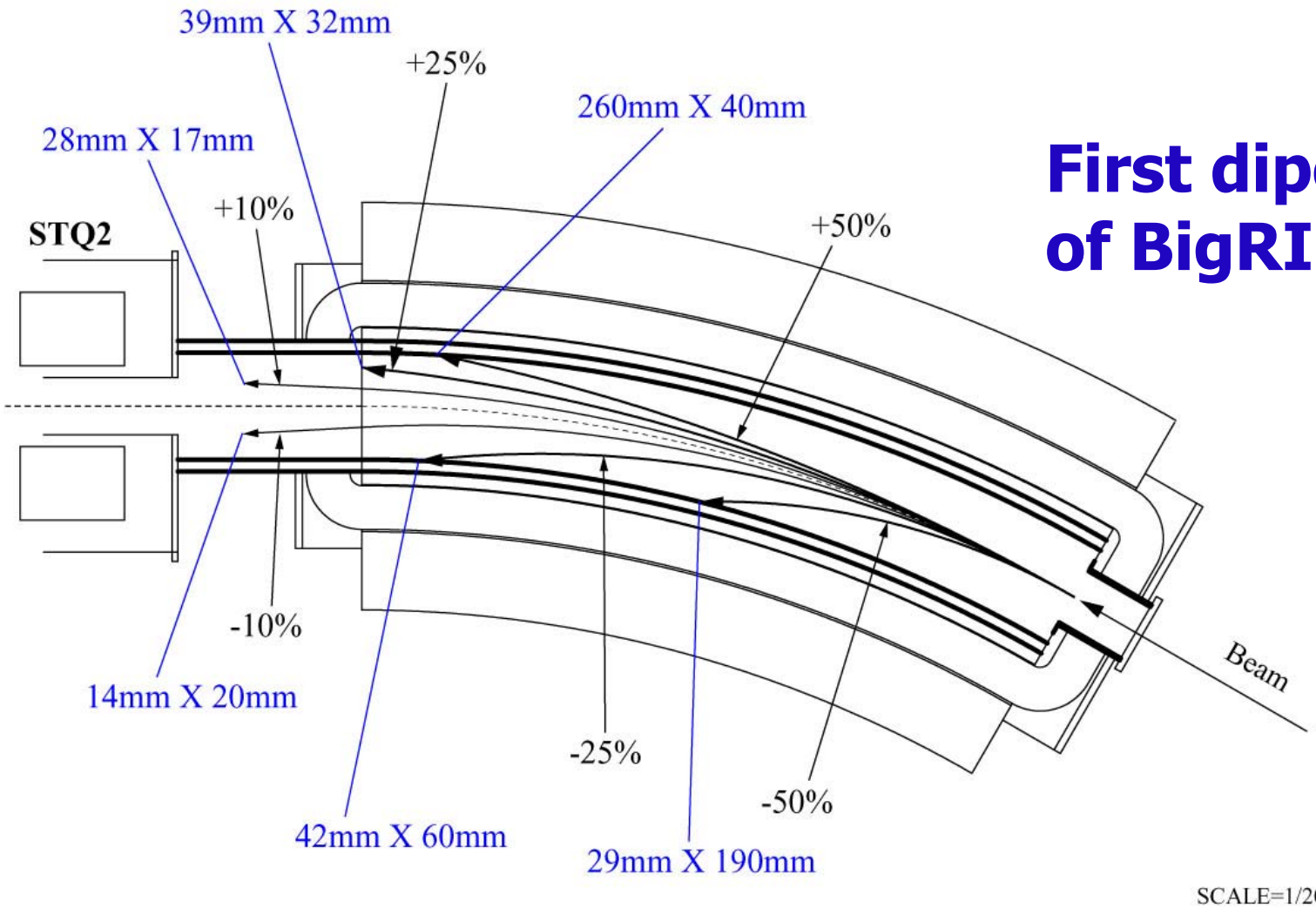


Primary beam traveling down separator





At RIKEN: Stopping position changes depending on relative momentum



Beam dumping at RIA

- **Clearly, with the higher acceptance, beam will be transported much further down separator**
- **RIKEN type solution not adequate**
- **More option opened to choose best dispersion vs magnification spot to handle beam dump**
- **… more work still needed on this topic**

Fragment Separator Issues

- Evaluate design options, match to rest of facility … whole site layout depends on this piece
- Include pre-separators to both separators
- Detail studies for “gas catcher” separator
- Calculate separation purity for several specific cases
- Study radiation damage and beam dump issues

Status

- tools to study basic behavior and detailed design criteria of RIA fragment separators are being developed and improved
- requirements for RIA are well quantified
- contamination of weak channels by secondary production in intermediate wedge is identified as major source of contamination
- pre-separator approach solves this problem
- beam dump power density requirements for present layout determined, detailed analysis under various scenarios ungoing
- Focusing of low velocity ions into gas catcher will require very large aperture devices … different options are being considered